NEW SCIENTIFIC INFORMATION THAT MAY IMPACT RADIONUCLIDE SOIL ACTION LEVELS AT ROCKY FLATS

INTRODUCTION

Background

The Rocky Flats Cleanup Agreement (RFCA) was signed by the Department of Energy (DOE), the Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE) on July 19, 1996 In addition to the annual review that is required by Paragraph 5 of RFCA, the agencies committed to conduct an annual review of the radionuclide soil action levels (RSALs), which were most recently calculated by the agencies in 1996 One question to be addressed during this annual review of the RSALs is whether there is any new scientific information available that may impact the RSALs The RSALs working group, which is comprised of staff from DOE, EPA, CDPHE, and the Kaiser-Hill team, is conducting the current RSALs review process, with input from stakeholders

Purpose

The purpose of this report is to summarize the new scientific information that was reviewed by the working group and to recommend whether the information should be considered in the current RSALs process, based on potential impacts to the RSALs The working group reviewed the following

1) Information on the likelihood, extent and impact of fires on resuspension of soil due to reduction of ground cover Data from Front Range and Rocky Flats fires, as well as fires that have recently occurred at other DOE sites, were reviewed

2) Results from two wind tunnel studies performed at Rocky Flats following a prescribed burn and a wildfire in 2000 These studies looked at resuspension of soils and vegetation greenup following the fires
3) A report describing air calculations in the old RESRAD model, the new RESRAD model, and the model used by the Risk Assessment Corporation
4) Recent studies and reports produced by the Actinide Migration Evaluation group on actinide transport and solubility, soil erosion, transport pathways, and other topics
5) Other recent studies and reports from the National Academy of Sciences, the National Research Council, the General Accounting Office, and Rocky Mountain Remediation Services that may impact the RSALs

FIRES

The 1996 RSALs, using EPA guidance, considered climatic conditions for an average year during a thirty-year period Several recommendations were received that episodic climatic events, such as fires, should also be considered in developing the RSALs Fires can result in a reduction of plant litter and vegetation cover for a period of time, which may impact the amount of soil that is resuspended following a fire Therefore, the working group reviewed data on the likelihood and impacts of fires along the Front Range and at Rocky Flats

Front Range Fires

Grass fire information for 1999 from the Colorado Forest Service is summarized in Attachment 1 It provides the number and size of grass fires that occurred in Colorado

and along the Front Range in 1999 This information is relevant to the current RSALs process and should be considered

Rocky Flats Fires

Data from the Rocky Flats Fire Department show that since 1997, an average of 1 6 wildfires per year have occurred on-site In the Rocky Flats Buffer Zone specifically, four wildfires and one prescribed burn have occurred since 1994 (see Table 1)

Table 1 Recent Buffer Zone Fires at Rocky Flats

Fire	Date	Number of Acres Burned (approximate)
1994 north Buffer Zone wildfire	March 1994	70
1996 south Buffer Zone wildfire	September 2, 1996	104
2000 south Buffer Zone prescribed burn	April 6, 2000	48
2000 east Buffer Zone wildfire	July 10, 2000	8
2000 northeast Buffer Zone wildfire	September 10, 2000	<1

Both qualitative and quantitative post-fire monitoring was performed at the locations of these Buffer Zone fires In general, each of the fires has proven beneficial to the plant communities at these locations by removing the accumulated dead plant litter, stimulating the growth of the native species, and recycling the previously tied-up nutrients In addition, the monitoring of the burned areas after these fires showed that the fires did not create large areas of completely bare ground While the depth of the plant litter was reduced, and much of the live above ground vegetation was consumed, there was still

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considerable material present to protect the actual soil surface after the fires A thin layer of plant litter, in addition to rocks and burned clumps of grasses, were present and served to protect the surface of the ground and reduce wind velocities at ground level These qualitative observations are further substantiated by quantitative data from the prescribed burn conducted in spring 2000 Monitoring results showed that while the volume of plant litter was reduced sixty-one percent by weight in the burned area, the actual area of litter cover on the ground was only reduced by seven percent (Exponent for Kaiser-Hill Company, L L C , 2001) Rock cover and bare ground cover each increased by approximately four percent in places that had been previously covered by live plants or dead plant litter (Exponent for Kaiser-Hill Company, L L C , 2001) Much of the plant material remaining after the fires can be attributed to the cooler and more rapid burning nature of the grassland fires at the Site, in contrast to that of the higher temperature fires typical of shrub and forest ecosystems (fine grass fuels versus wood fuels) Finally, after a rainfall immediately following the September 1996 fire, Site ecologists visited the burn area to determine if there had been visible erosion of soil or water transport of ashed material No visible water-wash of ash or soil was detected

This information on the reduction of ground cover due to fires that have occurred at Rocky Flats is relevant to potential soil resuspension after fires Therefore, it is also relevant to the RSALs and should be considered in the current RSALs process

2000 Prescribed Burn Wind Tunnel Study

A prescribed forty-eight acre burn was performed at Rocky Flats on April 6, 2000 Following the prescribed burn, wind tunnel testing was performed on the test burn area, as well as on adjacent unburned areas for comparison The purpose of the testing was to determine the impact of the prescribed burn on the potential for wind generated particulate soil emissions Tests were performed immediately after the prescribed burn and during each of the following two months to determine how the soil erosion rate would change during regrowth of vegetation in the burned area According to the results of this testing, although the burned area retained certain characteristics that limit wind erosion, such as soil crusts, rocks, and burned grass clumps, the erosion potential of the burned area was higher than that of the unburned area In addition, although the burned area had revegetated to a large extent after three months, its erosion potential remained higher than that of the unburned area Full recovery is hypothesized to require some amount of thatch buildup in addition to the overgrown vegetation Preliminary results show that resuspension rates increase by a factor of six to ten following a fire, but that the rates decrease rapidly over days to weeks as the readily eroded particles are removed by the wind (Midwest Research Institute for Radian International, 2000a) These conclusions on resuspension of soils relate directly to the RSALs and should be considered

2000 Wildfire Wind Tunnel Study

On July 10, 2000, a lightning strike started a wildfire in the Rocky Flats buffer zone that burned about eight acres of land containing actinide particles On August 22, 2000, wind

tunnel testing was started in the wildfire burn area The main purpose of this testing was to determine how the specific activity of plutonium in soil would compare with the specific activity in windblown dust resuspended from that same soil Secondarily, this testing was used to further evaluate the erosion potential in a slightly different soil and vegetative environment than the prescribed burn The results of this testing show that the resuspended surface soil in this burn area, especially in the respirable fraction, has less specific activity than the underlying surface soil that is not typically exposed to wind erosion In addition, the test results show that only a small percentage of the surface soil in this area has a particle size that can be suspended as dust emissions (Midwest Research Institute for Radian International, 2000b) These conclusions also relate directly to the RSALs and should be considered

Los Alamos, Hanford and Idaho Fires

Los Alamos National Laboratory

On May 4, 2000, in an effort to reduce some of the vegetative buildup in a forested area of the Bandelier National Monument, officials of the National Park Service ignited a prescribed burn The associated fire fighting efforts, however, caused an out of control fire, which in the end burned nearly fifty thousand acres Over seven thousand of these acres were on Los Alamos National Laboratory lands The fire, officially known as the Cerro Grande Fire, was fully contained by June 6, 2000 (Fresquez, Velasquez, and Naranjo, 2000)

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A study was performed by Los Alamos after the fire to determine if radionuclides, known to be present in soils and plants above background concentrations, may have been suspended and transported via smoke and ash during the fire This determination was made by comparing radionuclides in soil samples that were collected right after the fire to radionuclides in soil samples collected in 1999 The results showed that radionuclide concentrations in both sets of soil samples were statistically similar Therefore, Los Alamos concluded that impacts to area soils from the fire were minimal (Fresquez et al , 2000)

Los Alamos also performed a study to determine whether the increase in air concentrations of radionuclides during the fires resulted from Los Alamos derived radionuclides This determination was made by comparing ambient air samples collected before and during the fire Los Alamos concluded that the increase in air concentrations of radionuclides was due to products of radon decay, not Los Alamos derived radionuclides (Kraig, Gladney, and Eberhart, 2000) Finally, Los Alamos wanted to determine if the radiological doses resulting from the increased air concentrations during the fire were significant The conclusion reached was that the doses were insignificant and no future health effects are expected (Kraig et al)

Information is not currently available on resuspension of soils after the Cerro Grande Fire In addition, there is not a direct correlation of these study results to Rocky Flats soils, because the soils and vegetation are quite different between the sites Therefore,

the information that resulted from the Cerro Grande Fire is not applicable to the Rocky Flats RSALs process

Hanford Site

A wildfire that was sparked by a vehicle accident near the Hanford Site on June 27, 2000, burned nearly 164,000 acres of land on and off the Site The fire was fully contained on July 1, 2000 During the fire, the DOE Richland Operations Office Manager established a Type B accident investigation board, which focused its investigation and report on Hanford's emergency response actions during the fire (U S Department of Energy Type B Accident Investigation Board, 2000) Therefore, the information in the investigation board's report is not relevant to the RSALs

The Department of Energy Richland Operations Office, the State of Washington Department of Health, and the U S Environmental Protection Agency performed environmental monitoring and sampling at the Hanford Site during and after the fire Air and surface samples that were collected during the fire detected no radioactivity above normal background levels (U S Department of Energy Hanford Site, 2001a) Ambient air monitoring that was performed after the fire showed slightly elevated levels of radioactivity However, all three agencies agreed that these levels were well below the level of concern (U S Department of Energy Hanford Site, 2001b)

As discussed at the October 11, 2000, RFCA Stakeholder Focus Group meeting, the Hanford Site did experience sand and dust resuspension in burned areas after the fire, due

to wind and the lack of vegetation As with the Cerro Grande Fire, however, there is not a direct correlation of this information to Rocky Flats soils, because the soils and vegetation are quite different between the sites Therefore, the information available from the Hanford Fire does not affect the Rocky Flats RSALs process

Idaho National Engineering and Environmental Laboratory

A third wildfire that affected DOE lands occurred in July 2000 at the Idaho National Engineering and Environmental Laboratory, which also experienced significant soil resuspension as a result of the fire In a newspaper article related to the fire, a Bureau of Land Management spokesman stated that "the most severe erosion problems usually occur in the first six weeks after a range fire " (Langston, 2000) However, as with the two previous fires discussed, there is not a direct correlation between this information and Rocky Flats, so it is not applicable to the Rocky Flats RSALs process In addition, no other relevant information is available from this fire

Fire Safety and Preparedness Commission

As a result of these three fires that directly impacted DOE lands, the Secretary of Energy convened an independent Fire Safety and Preparedness Commission in November 2000 The goals of the commission are to 1) better prepare DOE against the threat of fires, 2) examine DOE's fire prevention and response systems, and 3) guide DOE's long-term approach to fire safety and preparedness The commission will prepare a final report at the end of its two year term (U S Department of Energy, 2000) Based on the goals of this commission and the fact that its term and report are far from final, this commission

currently has no impact on the RSALs However, relevant information from this commission should be reviewed during future annual reviews of the RSALs

AIR CALCULATIONS

In February 2001, Radian International completed a report describing air calculations in the old RESRAD models (Version 5 70 and earlier), the new RESRAD models (versions later than 5 70), and the model used by the Risk Assessment Corporation According to the Radian report, all three of these models will result in different RSAL values, due in part to the different air calculations in each The Radian report focuses on these different air calculations and concludes that although old RESRAD results in more restrictive RSALs, new RESRAD is based on more realistic and defensible assumptions It also concludes that the Risk Assessment Corporation model results in air calculations similar to new RESRAD Parameter inputs to new RESRAD and the Risk Assessment Corporation model are quite different, however, and the choices for these parameter values can influence the relative outcomes significantly (Radian International, 2001) Because the content of the Radian report is directly applicable to the current RSALs process, it should be considered in that process

ACTINIDE MIGRATION EVALUATION STUDIES

The Actinide Migration Evaluation group was formed to provide guidance on issues of plutonium, americium, and uranium behavior and mobility in air, surface water, groundwater, and soil Since the development of the 1996 RSALs, new information has

been obtained and some of the information that went into the calculation of the 1996 RSALs has been confirmed This information is discussed in the following sections

Actinide Transport and Solubility

The Actinide Migration Evaluation group has demonstrated that physical/particulate transport is the dominant mechanism for plutonium migration at Rocky Flats According to the group, plutonium that is found in Rocky Flats soils is generally highly insoluble and is attached to soil particles This is based on soil samples taken from the 903 Pad area and analyzed at the Stanford Synchrotron Radiation Laboratory using Extended X-Ray Absorption Fine Structure The results show conclusively that the 903 Pad soils contain plutonium in the tetravalent oxidation state, or plutonium dioxide This oxidation state is generally insoluble and relatively immobile in soils, sediments, and water This is significant because it has been believed for some time that the chemical form of plutonium at Rocky Flats is the dioxide, and these results scientifically validate that belief (Santschi, Roberts, and Guo, 2000) This information allows for a more accurate choice of the distribution coefficient, which is a key parameter in the RESRAD computer model It is key because it defines the relationship between the concentration of the contaminant in soil and in water It can also influence calculations involving contaminants in groundwater The distribution coefficient range that the group reported in a 1997 report is 0 98 x 10^4 to 1 16 x 10^5 cm^3/g, showing that plutonium is very insoluble (Honeyman and Santschi, 1997)

In June 2000, the Actinide Migration Evaluation group evaluated a January 2000 *Science Magazine* article on this subject of plutonium solubility (Haschke, Allen, and Morales,

2000) The group concluded that the information in the article does not change the conclusion reached by the group that plutonium oxides are not significantly soluble in water (Choppin, Clark, Janecky, Lane, and Nordstrom, 2000b)

In addition, the Colorado School of Mines completed a study to determine the types of materials in soils that tend to bind small particles together to form larger aggregates The study concluded that natural organic materials play an important role as the "glue" that holds the soil particles together Destruction of the organic material results in movement of the actinides to smaller sizes of soil particles This understanding is important in evaluating ways to control actinide mobility because small particles tend to be more mobile than larger ones (Honeyman, 1998) In conclusion, the Actinide Migration Evaluation group has determined that plutonium is generally insoluble and moves through physical transport mechanisms, such as colloidal transport This information on actinide transport and solubility is relevant to the RSALs and should be considered in the RSALs process

Contaminant Travel Times

The Actinide Migration Evaluation group is evaluating information in the 2000 National Research Council report titled *Research Needs in Subsurface Science*, for its relevance at Rocky Flats One section of this report discusses contaminant travel times to groundwater According to the report, low levels of plutonium have been found in the groundwater under the Idaho National Engineering and Environmental Laboratory Radioactive Waste Management Complex Waste in this area had been disposed of in

pits, trenches, soil vaults, an above-ground disposal pad, and septic tanks The report states that the presence of plutonium in the groundwater indicates that the plutonium traveled from the waste disposal area into the groundwater In addition, the report states that recent travel time estimates for radioactive contaminants to move into groundwater is in the tens of years, rather than in the tens of thousands of years that was estimated decades ago (National Research Council, 2000b) Results of the Actinide Migration Evaluation group's review of this information is still pending If appropriate, these results will be considered during a future annual review of the RSALs

Migration of Plutonium in Groundwater at the Nevada Test Site

The Actinide Migration Evaluation group evaluated the available information on migration of plutonium in groundwater at the Nevada Test Site According to the group, the situation at Rocky Flats is very different from that at the Nevada Test Site Therefore, the group concluded that " the primary similarity is the confirmation that one must include particulate transport in migration models " (Choppin, Clark, Janecky, Lane, and Nordstrom, 2000a)

Actinides in Groundwater

Fiscal year 2000 sampling of four specialized "aseptic" groundwater wells on-site indicate plutonium and americium concentrations in the low femtocurie per liter range In fiscal year 2001, the Actinide Migration Evaluation group will determine a path forward on this assessment of actinides in groundwater Therefore, at this time there is

no information to consider in the RSALs process Any new information should be included in future annual reviews of the RSALs

Soil Erosion and Surface Water Sediment Transport

The *Report on Soil Erosion and Surface Water Sediment Transport Modeling* sheds light on how overland flow and erosion processes affect surface water concentrations of actinides, especially for extreme floods The purpose of the modeling discussed in the report was to develop a management tool to evaluate erosional impacts of storm events during current and potential future site conditions (Kaiser-Hill Company, L L C , 2000) This information is not directly relevant to the RSALs since it has been shown that actinides are not soluble in water However, since this information is related to radionuclides in soils it should be kept in mind during the RSALs process

Additional work will be performed by the erosion and sediment modeling team in fiscal year 2001, including the evaluation of potential future scenarios such as remediation and range fires This information should be reviewed for relevancy to the RSALs during a future annual review of RSALs

Air Transport and Deposition

The air transport pathway was simulated with computer models to predict actinide concentrations in air for various future scenarios The scenarios range from release of actinides due to decontamination, demolition, and remediation activities, to range fires and high wind events The results of this air modeling study are presented in the report

Air Transport and Deposition of Actinides (Radian International for Kaiser-Hill Company, L L C , 2000) Because this information is relevant to the RSALs, it should be considered in the RSALs process

Uranium in Groundwater

A geochemical model for uranium in groundwater was completed for the Actinide Migration Evaluation group in fiscal year 2000 The model results indicate that uranium in solution is not precipitating to a solid mineral phase as it moves through the groundwater system This knowledge will help predict the rate of uranium movement in the groundwater, which is useful for designing long term methods for remediating uranium contaminated groundwater (Ball and Nordstrom, 1999) In addition, as part of a joint effort between the Colorado Department of Public Health and Environment and Rocky Flats, the isotopic composition of uranium in groundwater samples was determined by high resolution analytical techniques at the Los Alamos National Laboratory The data were used to distinguish between naturally occurring and man-made uranium in groundwater It was found that the uranium in groundwater on-site is naturally occurring, except in a few areas near sources (Rocky Mountain Remediation Services, 2000) This information on uranium in groundwater is relevant to the radiological dose that a certain type of future site user may receive, so it should be considered during the RSALs process

Actinide Contaminated Concrete

Samples of actinide contaminated concrete from Rocky Flats production buildings are being analyzed by the Los Alamos National Laboratory to determine the oxidation state(s) of the actinides The oxidation states of the actinides play a role in their mobility The data from this investigation will be used to determine what could happen to low-level contamination in and on concrete rubble and foundations Work is continuing on this study in fiscal year 2001 and currently no data or conclusions are available Although these data and conclusions will not be directly relevant to the RSALs process, it will be important to coordinate the results of both processes so that the management of concrete rubble (which may include use as on-site fill material) and concrete foundations (which may include leaving portions of some in place) is not inconsistent with the RSALs At this time, however, there is no information to be considered during the RSALs process

Actinide Pathway Report

Work began on the *Actinide Pathway Report* in fiscal year 2000 and is continuing in fiscal year 2001 This report will present the rates and quantities of actinide movement via surface water, groundwater, air, and biological transport pathways In addition, it will provide a range of actinide distribution coefficient values that are specific to Rocky Flats Finally, the pathways will be ranked in terms of mobility rate and quantity, and in terms of potential health risk Because this report is not scheduled to be complete until the end of fiscal year 2001, there is no information to consider in the RSALs process at this time The information in the report should be considered once it is complete, either during this process or during the next annual review of the RSALs, whichever is more appropriate

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OTHER STUDIES AND REPORTS

Biological Effects of Ionizing Radiation (BEIR) Studies

A National Academy of Sciences committee that was formed to study the biological effects of ionizing radiation issued a report (BEIR V) in 1990, which was previously considered by the RSALs working group BEIR VI was a 1999 assessment of risks from radon and is, therefore, not relevant to the RSALs The current BEIR VII committee (Committee on Health Risks from Exposure to Low Levels of Ionizing Radiation) was tasked in 1998 with reassessing the results of the BEIR V report The BEIR VII committee will review and evaluate scientific literature published since 1990 in order to assess the health risk to humans of exposure to low levels of ionizing radiation This project is scheduled to be completed in October 2003, at which time a final report will be issued (National Academy of Science, 2001)

Since the BEIR VII project is not yet complete, and no preliminary or interim information is available from the committee, there is no relevant information for the RSALs working group to consider at this time

Long-Term Stewardship

In Summer 2000, the National Research Council completed a report titled *Long-Term Institutional Management of U S Department of Energy Legacy Waste Sites* The report states that DOE's plans to rely heavily on long-term stewardship to oversee its sites after closure may be a problem According to the report, one of the main reasons for this

problem is that institutional controls are likely to fail in the future, which may expose the public to residual contamination at the sites The report also states, however, that projected future land uses should be considered in cleanup planning Therefore, the report recommends the use of a planning and decision-making approach called "long-term institutional management " This management tool calls for tradeoffs between contaminant reduction, contaminant isolation, and stewardship measures (including institutional controls) during cleanup (National Research Council, 2000a) In other words, all three of those factors should be considered and implemented, DOE should not rely on only one of them

The content and recommendations of this report are directly relevant to the RSALs Therefore, the agencies should consider the recommendations of this report when choosing a final RSAL from the numerous values that will be calculated Specifically, the agencies should consider all three factors in the "long-term institutional management" approach recommended by the report

U S General Accounting Office Report on Radiation Standards

In June 2000, the General Accounting Office issued a report titled *Radiation Standards Scientific Basis Inconclusive, and EPA and NRC Disagreement Continues* The study that led to this report had three goals 1) to determine whether current radiation protection standards have a solid scientific basis, 2) to determine whether the EPA and the Nuclear Regulatory Commission have come close to agreeing on radiation protection standards, and 3) to determine the impact of these standards on cleanup costs This report

concludes that current regulatory standards for radionuclides that are intended to protect public health lack a conclusive scientific basis, particularly for low levels of radiation In addition, the report concludes that the EPA and the Nuclear Regulatory Commission are not in agreement on these standards, and that a lower standard results in higher cleanup costs (U S General Accounting Office, 2000) These conclusions are relevant to current radiation protection standards rather than to the RSALs that are currently being calculated Therefore, there is no relevant information from this report to consider in the RSALs process

Availability of Shallow Groundwater

In 2001, Rocky Mountain Remediation Services prepared a white paper on the potential availability of shallow groundwater for residential use at Rocky Flats The paper was prepared in response to the RSALs working group inquiry as to whether the groundwater risk pathway at Rocky Flats had been eliminated The paper concludes that, in limited areas of the site, sufficient shallow groundwater might be available to supply a family of four with a minimum water supply (Rocky Mountain Remediation Services, 2001) This minimum water supply is very conservative and may not be sustainable Therefore, for the future land use scenarios where the use of shallow groundwater is possible, the RSALs process should consider whether the groundwater pathway is realistic

Soil Ingestion Studies

In 1989, a study of adult soil ingestion rates in Amherst, Massachusetts, was published (Calabrese, Barnes, Stanek, Pastides, Gilbert, Veneman, Wang, Lasztity, and Kostecki,

1989) The purpose of this adult study was to verify the tracer mass balance methodology used in a concurrent child study Although the study was not intended to directly investigate the amount of soil ingested by adults, it does offer an estimate of this In 1997, a study of child soil ingestion rates in Anaconda, Montana, was published (Calabrese, Stanek, Pekow, and Barnes, 1997) The information in these studies, as well as in numerous subsequent publications on the studies, is useful in quantifying the soil ingestion parameter Therefore, the information from both of these studies is applicable to the current RSALs process and should be considered

Radionuclide Soil Action Level Oversight Panel

In February 2000, the Risk Assessment Corporation completed a final report for the Radionuclide Soil Action Level Oversight Panel The objective of the report was to review the RSALs adopted by the agencies in 1996, as well as to recommend a technical method for independently deriving RSALs for Rocky Flats (Risk Assessment Corporation, 2000) Therefore, based on these objectives, the information in the report is applicable to the current RSALs process and should be considered

Drought

The 2000 report *A History of Drought in Colorado Lessons Learned and What Lies Ahead* contains information about droughts, Colorado's wet and dry seasons, and historical drought data for Colorado (McKee, Doesken, Kleist, Shrier, and Stanton, 2000) This information is relevant to the current RSALs process, particularly the mass

loading parameter Therefore, this report should be considered in the current RSALs process

Uncertainty in Risk Coefficients

In February 2000, the Radiological Assessments Corporation completed *Final Report Assessing Risks of Exposure to Plutonium* One subject of this report is uncertainty in risk coefficients (Radiological Assessments Corporation, 2000) This subject is applicable to the current RSALs process and should be considered

CONCLUSION

The RSALs working group reviewed a variety of new scientific information that may have an impact on the current RSALs process Based on these reviews and the discussions in this report, the agencies believe that the following new scientific information may impact the RSALs and should be considered in the current RSALs process

1) The likelihood and extent of Front Range grass fires
2) Reduction of ground cover and potential soil resuspension in burned areas after a fire
3) The description and comparison of air calculations using various computer models
4) Actinide transport and solubility studies and data
5) The report on soil erosion and surface water sediment transport
6) The report on air transport and deposition of actinides
7) The geochemical model for uranium in groundwater

8) The three factors in the "long-term institutional management" planning and decision making tool

9) The potential availability of shallow groundwater at Rocky Flats

10) Soil ingestion studies

11) The Risk Assessment Corporation report for the Radionuclide Soil Action Level Oversight Panel

12) The 2000 report on drought in Colorado

Finally, the RSALs that are developed in this process should be scientifically defensible and agreed upon by all agencies involved

ATTACHMENT 1

1999 Colorado Forest Service Fire Data Summary

Total fires reported in 1999	=	2520	
Total grass fires reported in 1999	=	1670	(66% of total fires)
Total grass fires > 100 acres	=	66	(4% of grass fires)
Total acres of grassland burned	=	62734	Acres
Average size of grassland fire	=	38	Acres
Size range of grassland fires	=	0 1-10,000	Acres
Std deviation - size grass fires	=	395	Acres

Total grass fires along Front Range= (T5N-T5S, R69-70W)	390	
Ave size of grass fire =	1 19	acres
Standard Deviation =	17 95	
Total grass fire acres =	465 18	acres
Total "Front Range" area =	460,800	acres (720 sq mi)
Probability of fire per acre = (grass fire acres/Front Range area)	0 001	

MONTHLY GRASS FIRE DATA -1999

Month	# Fires	Ave. size	Tot. acres
January	94	68 8	6471
February	216	113 4	24488
March	394	20 7	8168
April	133	4 0	529
May	86	0 5	41
June	107	0 8	83
July	157	49 1	7707
August	77	2 1	159
September	72	8 8	635
October	115	17 9	2053
November	99	75 6	7489
December	19	0 1	2

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